

# Compendium

## Vestibular Disease: Diseases Causing Vestibular Signs

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**Abstract:** Having determined whether a patient has central or peripheral vestibular disease, clinicians must then determine what diseases are likely to result in such a presentation. This article describes the more common diseases causing vestibular disease in dogs and cats. Having formulated a list of potential causes of vestibular disease, clinicians should proceed through a systematic investigation to diagnose the underlying condition. A companion article describes the anatomy, physiology, and clinical signs associated with vestibular disease.

For more information, please see the companion article, "Vestibular Disease: Anatomy, Physiology, and Clinical Signs."

**T**ABLE 1 details the differential diagnoses for dogs and cats with peripheral and central vestibular disease and highlights some of the more commonly seen causes. Following are more complete descriptions of these diseases and conditions.

### Idiopathic Vestibular Disease

Idiopathic vestibular disease causes peripheral disease and occurs in both dogs and cats. In dogs, it has also been called *old dog vestibular disease* or *geriatric vestibular disease*, given the age at which patients present.<sup>1</sup> In cats, idiopathic vestibular disease appears to be a separate entity, occurring more commonly in young adult cats in the north-eastern United States from late spring to early fall.<sup>2,3</sup> *Cuterebra* larval migration has been suggested to be the cause for this seasonal vestibular disorder.<sup>4,5</sup> Both canine and feline diseases are characterized by an acute onset of signs that can be severe and crippling, including rolling, nystagmus, falling, and a head tilt. Other deficits are not usually seen; therefore, a patient with Horner syndrome or facial nerve signs should be investigated for other causes (e.g., otitis media, otitis interna). No treatment has proved beneficial, although symptomatic management of nausea is occasionally advantageous. An improvement is commonly seen within the first few weeks, with the nystagmus usually resolving within the first few days. Most animals make a complete recovery, although severely affected animals occasionally maintain a residual head tilt. This disease can result in bilateral vestibular signs, particularly in cats.<sup>6</sup>

### Otitis Media and Otitis Interna

Otitis media and otitis interna are among the most common etiologies of peripheral vestibular disease in dogs and cats.<sup>1,7,8</sup>

Most commonly, they are the result of one of the following:

- A descending infection from the external ear canal
- Spread of organisms from the pharynx via the auditory tube
- Hematogenous spread of infectious organisms

Ipsilateral facial paralysis is a common finding in patients with middle or inner ear disease, and treatment involves the administration of systemic antibiotics for a minimum of 4 to 6 weeks (the choice of antibiotics depends on culture and sensitivity results from myringotomy). In severe cases, surgical management may be necessary. The prognosis is guarded to fair, although a residual head tilt and/or facial paralysis is possible.

Occasionally, intracranial infection can result from extension of a middle ear infection along the nerves and vessels of the internal acoustic meatus or by hematogenous spread. This can result in signs of central vestibular disease.

### Meningoencephalitis of Unknown Etiology

Pathogen-free inflammatory brain disease is relatively common in dogs and rare in cats.<sup>9</sup> Several distinct types of inflammatory brain disease are recognized (e.g., granulomatous meningoencephalomyelitis, necrotizing encephalomyelitis), although a definitive diagnosis is only obtained by histopathology (currently rarely performed). Clinical signs are typically acute or progressive and may involve many parts of the brain, leading to central vestibular signs in conjunction with seizures or central blindness. A presumptive diagnosis can be made based on a consistent history, signalment (frequently young to middle-aged female terrier breeds), multifocal contrast-enhancing lesions on magnetic resonance imaging (MRI), a mononuclear or mixed cell pleocytosis on analysis of cerebrospinal fluid, and exclusion of infectious etiologies by serologic and polymerase chain reaction testing. Treatment involves

**Table 1. Causes of Vestibular Signs in Dogs and Cats<sup>a</sup>**

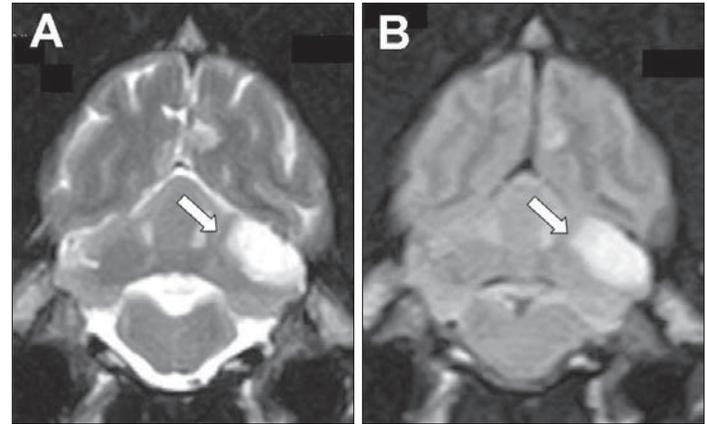
Disease Process or Condition	Diseases/Conditions Causing Peripheral Signs	Diseases/Conditions Causing Central Signs
Vascular	—	<i>Brain infarct</i> Brain hemorrhage Feline ischemic encephalopathy
Idiopathic	<i>Idiopathic vestibular disease</i>	—
Traumatic	Head trauma	Head trauma
Toxic	Systemic aminoglycosides Topical chlorhexidine	Metronidazole toxicosis Lead toxicosis
Anomalous	Congenital vestibular disease	Cystic malformation Hydrocephalus
Endocrine/metabolic	Hypothyroidism (dogs)	Hypothyroidism (dogs; rare)
Inflammatory/infectious	<i>Otitis media/interna</i> Nasopharyngeal polyps (cats)	<i>Meningoencephalitis of unknown etiology</i> (e.g., granulomatous meningoencephalitis) (dogs); infectious encephalitis (canine distemper, <i>Toxoplasma</i> spp, <i>Neospora</i> spp, bacteria, FIP, and fungal disease)
Neoplastic	Middle or inner ear tumor Peripheral nerve tumor	<i>Caudal fossa tumors (primary or metastatic)</i>
Nutritional	—	Thiamine deficiency
Degenerative	—	Lysosomal storage diseases Abiotrophies

<sup>a</sup>The more common diseases are italicized.

immunosuppressive doses of glucocorticoids frequently in combination with another immunomodulatory agent (e.g., cytosine arabinoside, cyclosporine). However, an optimal regimen has yet to be established. I currently use doses of prednisolone and cytosine arabinoside according to a published protocol.<sup>10</sup> Prognosis is extremely variable and depends in part on the severity of presenting signs.

### Intracranial Neoplasia

Tumors can cause central (intracranial disease) or peripheral (middle ear neoplasia and peripheral tumors of cranial nerve VIII) vestibular signs. Central vestibular signs usually result



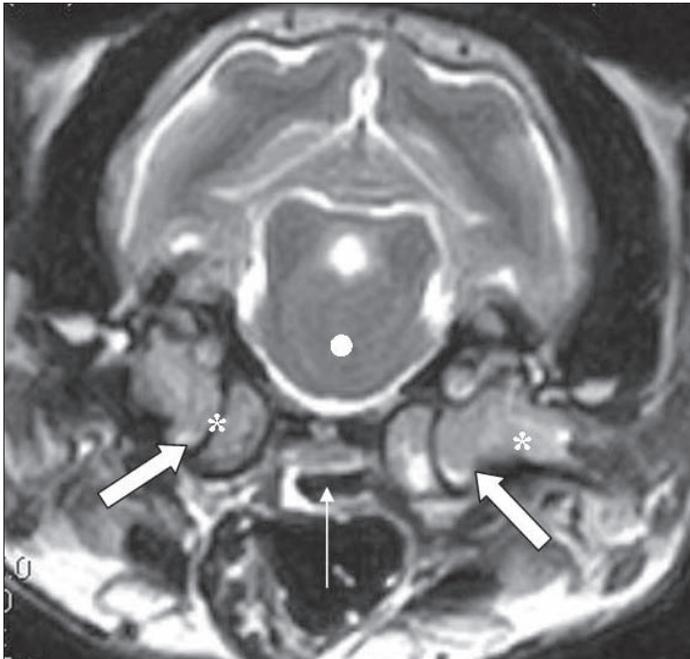
**Figure 1.** MRI scans of an 8-year-old greyhound showing a left-sided cerebellar infarct in the territory of the left rostral cerebellar artery (*white arrows*). This dog had signs of paradoxical vestibular disease, with a head tilt to the right, vertical nystagmus, and left-sided proprioceptive deficits. Scan A is a T2-weighted image revealing a hyperintense, well-defined region in the cerebellum. On scan B, which is a fluid-attenuated inversion recovery (FLAIR) image, the area remains hyperintense and does not suppress. This finding, combined with a lack of contrast enhancement, is typical of an ischemic infarct.

from primary neoplasia within the caudal fossa (e.g., meningioma, choroid plexus tumor, ependymoma, glioma, medulloblastoma) or secondary metastatic disease (e.g., lymphosarcoma, hemangiosarcoma, carcinoma). Prognosis is generally poor, although cases must be evaluated individually, as various options for management depend on the type and location of the tumor.

### Cerebrovascular Accident

A cerebrovascular accident or stroke is an increasingly recognized cause of the acute onset of neurologic signs in dogs and cats.<sup>11</sup> A stroke simply describes a disruption in the blood supply to the brain and is the result of an ischemic infarction (for example, due to vessel occlusion or altered blood viscosity) or a hemorrhage. Ischemic infarctions are the most common manifestation of strokes in dogs and cats. They often occur in the cerebellum, resulting in signs of central and paradoxical vestibular disease and are diagnosed by means of MRI (**FIGURE 1**). Uncommonly, diencephalic lesions may occur, resulting in ipsilateral central vestibular signs.<sup>12</sup> The term *transient ischemic attack (TIA)* is used to describe an abrupt onset of focal neurologic signs lasting less than 24 hours. In humans, these signs are believed to be the result of functional ischemia, often preceding an ischemic infarction. The distinction of a TIA from an ischemic infarction is that TIAs are extremely short-lived and are not readily visible on MRI. Due to their transient nature and the lack of a definitive test, TIAs are poorly understood in veterinary medicine, although anecdotal reports suggest that they occur.

In cases of suspected infarct, underlying hypertension, hyperadrenocorticism, hypothyroidism, and cardiac or renal disease should be investigated. An underlying cause is found in approximately 50% of dogs suffering an infarct.<sup>13</sup> The prognosis for patients in which a predisposing medical condition is identified has been



**Figure 2.** An MRI scan from a cat with vestibular signs due to inflammatory polyps. Notice the polyp positioned in the oropharynx (*line arrow*) and the subsequent bilateral otitis media and otitis interna (*block arrows*). \* = tympanic bullae, ● = brainstem.

found to be much poorer than for those in which a cause is not found. Many animals with infarcts improve given time and supportive care.

### Hypothyroidism

Hypothyroidism can manifest as peripheral or central disease in dogs.<sup>14</sup> However, the pathogenesis for these two presentations is different. Peripheral vestibular signs can be caused by polyneuropathy associated with hypothyroidism. The pathogenesis of this phenomenon is unknown, but treatment of hypothyroidism can result in improvement of the vestibular signs. Hypothyroidism can also cause bilateral vestibular disease.

Myxoedematous disease associated with hypothyroidism can cause peripheral or central vestibular signs. Myxoedematous deposits are thought to develop alongside cranial nerves as they exit the skull foramina, causing compression and a neuropathy.

Diagnosis of hypothyroidism is by demonstration of a low serum thyrotropin ( $T_4$ ) level and an elevated thyroid-stimulating hormone (TSH) concentration. Thyroid hormone supplementation usually results in improvement within a few months.

### Thiamine Deficiency

Thiamine deficiency is a rare cause of central vestibular disease in dogs and cats.<sup>8,15</sup> Most cases are the result of inappropriate food preparation, inadequate dietary concentration, or diets high in thiaminases (found in high concentrations in raw fish). Liver and gastrointestinal disease can also result in thiamine deficiency due to decreased thiamine absorption or metabolism. The pathologic

changes are symmetric and focal, causing selective destruction of certain brainstem nuclei. Therefore, bilateral vestibular disease without significant changes in mentation is one possible presentation of this disease. Often, a presumptive diagnosis is made based on the history, neurologic examination, and MRI findings. Urinary organic acid screening and measurement of transketolase activity in red blood cells give a more definitive diagnosis. Urinary organic acid screening can be performed using the diagnostic services of PennGen Laboratories (<https://netapps.vet.upenn.edu/PennGen/SampleTesting/default.aspx>); however, measurement of transketolase activity is technically very difficult and not currently commercially available. Most affected dogs and cats respond rapidly to oral thiamine supplementation at a total dose of 50 to 250 mg q12h for at least 4 weeks.

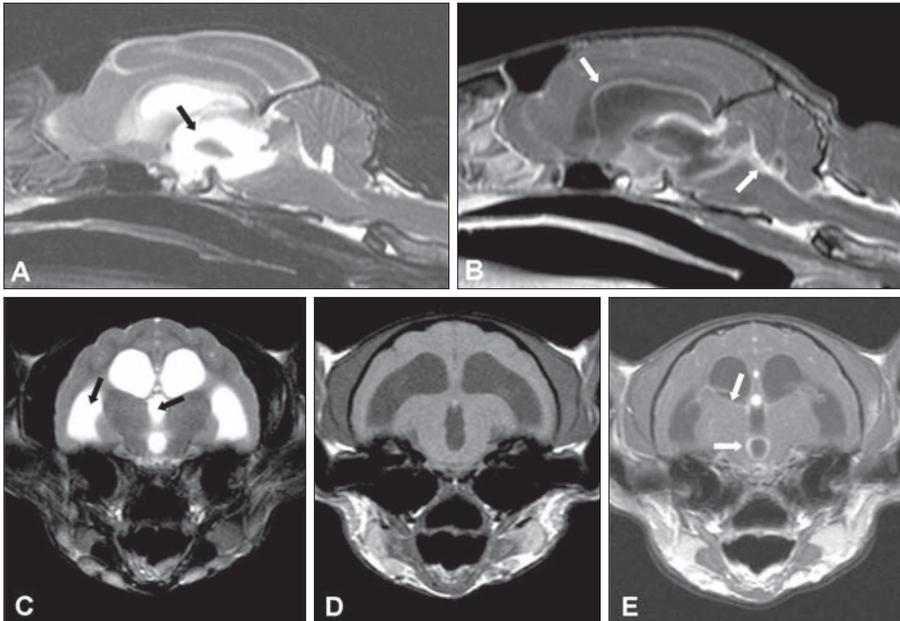
### Metronidazole Toxicosis

Metronidazole toxicosis resulting in central vestibular disease can affect dogs and cats. It is usually seen in animals receiving high doses of the medication.<sup>16</sup> However, because metronidazole undergoes hepatic metabolism, animals with liver dysfunction may develop signs of vestibular disease despite appropriate doses of metronidazole. Therefore, the history of any patient presenting with vestibular signs should be thoroughly reviewed to ensure the patient has not received this medication. Treatment with diazepam has been reported to speed recovery, although the exact mechanism of action is uncertain. I use a diazepam dose of 0.5 mg/kg q8h for at least 5 days or until a complete remission of clinical signs is obtained. Prognosis is very good if early intervention is achieved.

### Inflammatory Polyps

Polyps are the most common benign pharyngeal and external/middle ear masses observed in cats. They can occur in cats of any age, although they are typically seen in cats younger than 2 years. Polyps may be unilateral or bilateral, and clinical signs depend on their location, with upper respiratory signs resulting from polyps in the nasopharyngeal region and vestibular signs resulting when a polyp affects the middle ear.<sup>17</sup> Suspicion for an inflammatory polyp should increase when a cat presents with respiratory signs preceding a peripheral vestibular episode. Polyps can originate in the eustachian tube and consequently block drainage from the middle ear, leading to clinical signs of ear disease and hence peripheral vestibular signs; they may also occur secondary to infection. Diagnosis can be made using radiography or advanced imaging (**FIGURE 2**). When a polyp is located in the middle ear, treatment involves surgical removal either by gentle traction or ventral bulla osteotomy. If simple traction does not completely remove the polyp, the polyp and clinical signs may recur. Ventral bulla osteotomy is a preferable technique with a recurrence rate of 25% to 50%.<sup>18,19</sup>

When the middle ear is involved, tissue and/or fluid samples should be submitted for bacterial culture and sensitivity testing because bacterial otitis media may also be present. The prognosis for this condition after surgical removal is excellent when the polyp is completely removed.



**Figure 3.** MRI scans from a cat with central nervous system FIP. T2-weighted midline sagittal (A) and transverse (C) images reveal obstructive hydrocephalus of the third and lateral ventricles (black arrows). T1-weighted postcontrast sagittal (B) and pre- and post-contrast transverse images (D and E, respectively) of this same region reveal enhancement around the third and lateral ventricles (white arrows) following administration of an intravenous contrast agent (gadolinium). These features are indicative of FIP, in which a pyogranulomatous inflammation is seen on the surface of the brain involving the meninges. Central vestibular signs were present in this cat and occurred intermittently, most likely as a result of the obstructive hydrocephalus. Occasionally bilateral vestibular signs can be seen in this disease. FIP should be suspected in cats younger than 2 years or older than 9 years. The prognosis for FIP within the central nervous system is poor.

### Investigation

Regardless of whether a central or peripheral lesion is suspected, a full hematology and biochemistry panel should be performed. Measurement of total thyrotropin ( $T_4$ ), endogenous TSH, and free  $T_4$  (by equilibrium dialysis) is useful to diagnose hypothyroidism in dogs.<sup>20,21</sup> In an older patient, chest radiography and abdominal ultrasonography should be performed to exclude the possibility of systemic conditions with spread to the nervous system (e.g., a paraneoplastic syndrome, metastatic disease). Brainstem auditory evoked response (BAER) testing may be abnormal if the brainstem, peripheral nerve (cranial nerve VIII), or ear are involved. Occasionally, it is possible to extrapolate the location of a lesion from the results of this test.

If peripheral vestibular disease is suspected, a thorough examination of the external ear canal with the aim of visualizing the tympanic membrane should be performed with the patient under anesthesia. However, the presence of an intact tympanic membrane does not eliminate the possibility of disease affecting the middle ear. If the tympanic membrane is ruptured, swabs of the middle ear may be taken for culture and sensitivity testing. If the tympanic membrane is intact but appears abnormal, then a 20-gauge spinal needle can be used to puncture the membrane to obtain samples for culture and sensitivity testing. Lavage of the middle ear may also be required. However, lavage must be done only with warm saline. Chlorhexidine and aminoglycosides are toxins that cause

vestibular disease and will make clinical signs far worse if used to clean the ear. Radiographic evaluation of the tympanic bullae has been reported, but the sensitivity of this procedure is low (i.e., a normal radiograph does not rule out middle ear disease), and it is now recommended that computed tomography (CT) or MRI be performed whenever possible<sup>3</sup>.

Patients with central vestibular disease usually require advanced imaging (CT or MRI). Depending on the results of the imaging, further tests may be performed, including cerebrospinal fluid analysis (nucleated cell count, cytology, and total protein concentration) and titers for various infectious organisms such as *Toxoplasma gondii*, *Neospora caninum*, and the causative agents of canine distemper and FIP (FIGURE 3). If a specific cause is suspected, such as thiamine deficiency or a cerebrovascular accident, further tests may be warranted to confirm the diagnosis or to investigate underlying causes of the problem.

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**1. Which statement is true regarding idiopathic vestibular disease?**

- a. Vestibular signs can be bilateral, especially in cats.
- b. It should be a diagnostic differential for a dog presenting with Horner syndrome.
- c. Elderly cats are predisposed.
- d. None of the above

**2. Which statement is true regarding otitis media and otitis interna?**

- a. Vestibular signs are usually peripheral.
- b. They can result from an infection that originates in the external ear canal.
- c. Infection can enter from the pharynx via the auditory tube.
- d. all of the above

**3. Clinical signs associated with meningoencephalitis of unknown origin**

- a. tend to be chronic and progressive.
- b. may include central vestibular signs and seizures.
- c. rarely include blindness.
- d. none of the above

**4. Which statement is true regarding meningoencephalitis of unknown origin?**

- a. Treatment may include immunosuppressive doses of glucocorticoids.
- b. Prognosis is variable.
- c. Furosemide helps reduce brain inflammation.
- d. a and b

**5. Which statement is false regarding intracranial neoplasia?**

- a. Associated vestibular signs may be central or peripheral.
- b. Neoplasia can be primary or secondary.
- c. A peripheral tumor of cranial nerve VIII will cause central vestibular signs.
- d. none of the above

**6. Which statement is true regarding suspected ischemic infarction in dogs?**

- a. An MRI can often confirm the diagnosis.
- b. The long-term prognosis is likely poor, regardless of the underlying cause.

- c. Hyperadrenocorticism, renal disease, and hypothyroidism are among the potential underlying conditions that should be investigated.

- d. a and c

**7. Which statement is true regarding thiamine deficiency?**

- a. Clinical signs of vestibular disease are usually peripheral and unilateral.
- b. Urinary organic acid screening can confirm a diagnosis.
- c. Gastrointestinal disease is unlikely to have a significant effect on thiamine absorption.

- d. b and c

**8. In which of the following patients might an inflammatory polyp be suspected?**

- a. a relatively young cat with respiratory signs preceding a peripheral vestibular episode
- b. a middle-aged cat with bilateral facial paralysis
- c. an elderly cat with respiratory signs preceding a peripheral vestibular episode
- d. a young cat with central vestibular signs and no known history of illness

**9. Which statement is accurate concerning the tympanic membrane?**

- a. If the tympanic membrane has already ruptured, culture and sensitivity testing have limited diagnostic value due to increased risk for bacterial contamination.
- b. The presence of an intact tympanic membrane does not eliminate the possibility of disease affecting the middle ear.
- c. If the tympanic membrane is intact but appears abnormal, lavage of the middle ear using warm, dilute chlorhexidine may be required.
- d. none of the above

**10. Which of the following is not among the diagnostic recommendations for a pet presenting with vestibular disease?**

- a. thyroid testing in a dog
- b. titers for *Toxoplasma gondii*, canine distemper, or FIP
- c. myelography
- d. thoracic radiography and abdominal ultrasonography in an older patient